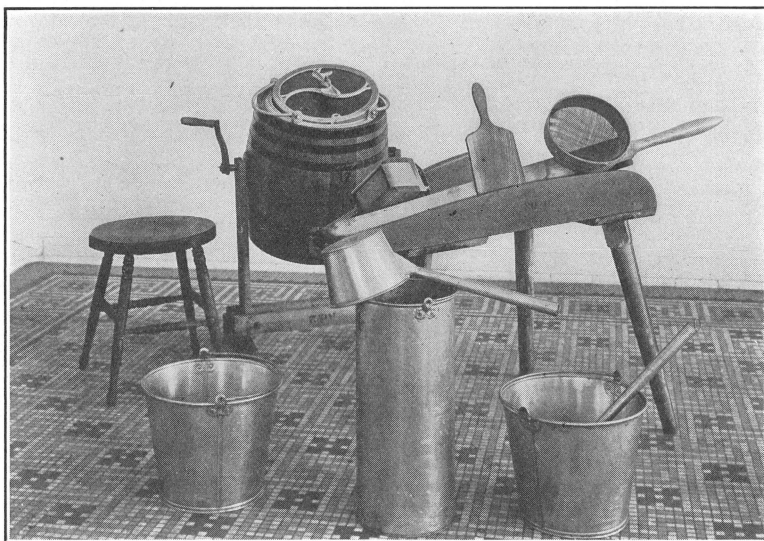


JULY, 1915

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THE PENNSYLVANIA STATE COLLEGE  
SCHOOL OF AGRICULTURE  
Agricultural Experiment Station



(Farm Butter Making Apparatus)

A Study of the Manufacture of Dairy  
Butter; Methods of Making  
Farm Butter

STATE COLLEGE, CENTRE COUNTY, PENNSYLVANIA

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## A STUDY IN THE MANUFACTURE OF DAIRY BUTTER

BY E. L. ANTHONY

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### SUMMARY.

1. Several educational contests conducted among the dairy buttermakers of Pennsylvania in connection with these studies show that there is a great lack of uniformity in farm butter. They also show that the average percentage of moisture in farm butter is very low.

2. The variations found in farm butter are to some extent due to the churns used, but are more especially due to the methods now used in churning and in the handling of the cream during the ripening process.

3. Overripened cream does not produce butter of as good quality as cream ripened to the proper degree. Creamery operators are inclined to use a lower degree of acidity in churning cream than was formerly used, and these studies indicate that this is advisable for farm butter as well. It is advised that cream be not ripened to more than .5 per cent of acid; as little as .4 per cent is sufficient under average farm conditions. Butter with lower acidity is being demanded by the market.

4. Attention to the following details of handling farm cream will afford better results than the present methods: Cool all cream down to 45 degrees; add each gathering, stir and hold the cream at this temperature until enough is secured for churning, and then warm it up to 75 degrees and allow .5 per cent of acid to develop;

Or ripen the first gathering at once to .3 per cent of acid, then cool to cellar or holding temperature, and add the additional gathering, after it has been cooled, to the already ripened cream;

Or use a good starter or small amount of butter-milk in the first cream gathering, keeping the latter as cool as possible until it is ready to churn; if the cream ripens too slowly warm until .5 per cent of acid is developed. The use of butter-milk as a starter may, however, injure the keeping quality of the product.

5. Butter should be carefully worked. Butter not sufficiently worked will be gritty and mottled; overworked butter will be weak in grain and body.

6. To secure good butter from farm cream, care and cleanliness must be observed in the handling of the cream, in the churning and working operations, and also as to the temperatures used.

7. If considered desirable a high moisture content can be secured as well in farm butter as in creamery butter, if care is used in regulating the period of churning as well as the temperatures used.

8. These studies show that with the common, hand butter-worker moisture is gradually lost as the working progresses, while with the combined churn the moisture increases after a certain period in working the butter.

### STUDIES IN FARM BUTTER.

During 1913 four educational butter-making contests were conducted by the Dairy Department of The Pennsylvania State College for the makers of farm butter throughout the State. The purpose of these contests was two-fold: (1) To study the quality of the butter made on the farm and its method of manufacture and to suggest methods of improvement; (2) to secure enough samples of farm butter to afford an accurate knowledge of the present quality and character of this product. The facts secured afforded a basis for studies to improve the quality and to secure uniformity of product, and brought out many points of value to dairy butter-makers.

### CONDENSED REPORT OF THE FOUR CONTESTS SHOWING THE WIDE VARIATION FOUND.

	April	June	August	October
No. of Samples.....	63	53	37	34
Score 90, or above.....	42	30	24	21
Highest Score.....	92.5	92.5	92.5	93.0
Lowest Score.....	80.	86.	85.	85.
Average Score.....	89.7	89.6	89.8	89.9
Highest Salt.....	9.1	5.4	4.8	4.5
Lowest Salt.....	.45	.40	1.3	.2
Highest Moisture.....	16.8	15.6	15.4	15.3
Lowest Moisture.....	8.	8.	8.	6.6
No. of poor or ill-shaped packages	34	25	12	8
No. of neatly-packed samples....	29	28	25	26



While many of the samples were received in good condition, yet in the first contest, as the table shows, there was much lack of uniformity in the style of package.

The common criticism made by the judge of the samples submitted was the great variation in the flavors, much of the butter being found defective through tainted condition or old age of cream used. The table also shows a wide variation in moisture and salt contents. The description accompanying each sample as to method of manufacture clearly indicated that there is a great contrast in the practices now in use on farms. These differences in method are no doubt the cause in part at least of the inequalities found in farm butter.

There is a great demand for knowledge about farm butter-making. This is due in a large measure to the great amount of farm butter made in this State. Pennsylvania occupies first place in the production of dairy butter. In 1909 there were made 61,138,000 pounds of farm butter, valued at \$15,668,000.00.

With the numerous large markets within easy reach of nearly every farm, the present large production could be increased if the uniformity of the butter could be maintained and the quality improved.

Farm butter is often discriminated against on the market because of its lack of uniformity in flavor, body, salt, moisture, and package.

### EXPERIMENTAL WORK.

The experimental work related to two operations: (1) The handling of the cream and milk before churning; (2) the churning and working of the butter.

As to the first operation the following points were considered:

1. The effects of different amounts of acid in the cream before churning.
2. The effects of different methods of holding and ripening cream for farm butter-making.

3. The effects of different kinds of starter used in ripening cream.

As to the second operation the points considered were:

1. The effects of the different kinds of churns used.
2. The effects of different end points in churning.
3. The effects of various degrees of working upon the butter.
4. The variations caused in churning as the rise in temperature, amounts of salt and moisture in the butter, and the loss of fat in the butter-milk.
5. The best point at which to stop churning farm cream.
6. The moisture percentage in farm butter at the different steps in manufacture.

### EFFECTS OF DIFFERENT CHURNS USED.

The object of this experiment was to show the variations found between the different styles of common farm churns, as to the percentages of moisture and salt secured in the butter as well as the length of time required for churning, the amount of fat left in the butter-milk, and the average rise of temperature of the butter-milk during churning.

With the three churns used, the method of procedure was exactly the same. For each test a quantity of ripened cream ready for churning was divided into three parts, one part being used for each churn. The temperature of the cream and of the wash water and the amount of the latter were the same in each case; and the butter was worked in the wash water the same number of times, as well as in the same manner, as nearly as possible. The results given below are the average for ten churnings in each churn:

#### Observations.

Kind of Churn	Butter		Time of Churning	Rise of Temperature Deg. Fahr.	Fat in Butter Milk %
	Moisture %	Salt %			
Barrel, (5 gal.).....	13.39	4.0	40 min.	60.3	.19
Swing churn (4 gal.).....	13.5	3.8	47 min.	61.0	.229
Combined churn and worker (18 gal.).....	13.6	2.45	29 min.	59.0	.18

These results show that the combined churn and the barrel churn churned somewhat closer than the swing churn, thus leaving less butter-fat in the butter-milk. This is probably due to the character of the agitation within the former two churns and to the fact that the temperature of the cream rose less during churning. The granules, after butter started to break, gathered more slowly than in the other churn. This permitted better separation of the fat from the butter-milk before the granules became so large as to require the stopping of the churning.

The moisture content averaged a little higher in the butter from the combined churn. This is probably due to the fact that the butter in this type of churn is worked in the water. This water is expelled from the butter during the working and is held in the churn instead of being allowed to run off, as is the case when butter is worked on a common hand-worker. After partial working, the butter begins to reincorporate or take up this moisture.

There was a smaller rise in the temperature of the cream during churning in these two churns. It was difficult to keep the temperature of the cream in the swing churn used from rising too high during churning because the lid, which is only set on the churn, allowed air from the room to circulate within the churn. A churn which holds the cream near the temperature at which the churning was started is preferable, because the butter comes out firmer, and is, therefore, more desirable to work.

#### ACIDITY VARIATIONS IN CREAM.

The object of this experiment was to determine what percentage of acid in the cream is best for churning under farm conditions. A quantity of sweet cream of average quality was taken from the general supply furnished the college creamery and divided into five equal parts.

The first part was cooled at once to churning temperature, held for two hours, and then churned. The acid test made when the churning was begun gave .2 per cent.

The second part was ripened at 75 degrees until it had developed .3 per cent of acid, after which it was cooled at once to churning temperature, held for two hours, and then churned.

The third part was treated in the same manner as the second, except that it was ripened to .4 per cent of acid.

The fourth part was treated in the same manner, except that .5 per cent of acid was developed before churning.

The fifth part was held at 75 degrees until it had developed the fullest possible amount of acid, which was found to be .85 per cent. It was held seventy-two hours at that temperature and was then cooled down to the churning temperature, held two hours more, and then churned.

The procedure was the same for all the churnings. A temperature of fifty-two degrees was used, the temperature of the wash water being fifty-four degrees. In the table below are given the scorings made by the judge, Mr. C. F. Fryhofer, Federal Butter Inspector. The salt and moisture content also are given. These butters were held a month in the refrigerator at forty-five degrees and again scored to see how they kept. The results are given in the second table.

#### First Scoring.

Acidity in Cream	.2%	.3%	.4%	.5%	.85%
Moisture, % .....	13.2	13.4	13.3	12.8	15.5
Salt, % .....	2.5	1.7	2.1	1.5	1.5
Fat in butter-milk, %	.52	.23	.20	.25	.4
Score .....	89	91	92	92	86
Criticism .....	Tainted	Mild flavor	Slightly old flavor	Slightly old flavor	Cheesy, old, due to old cream

#### Second Scoring (4 weeks later).

Acidity	Score	Criticisms
.2%	85	Undesirable flavors, old, tainted.
.3%	88	Old flavor, tainted.
.4%	87	Old, tainted flavor, peculiar flavor.
.5%	87	Old, tainted flavor.
.85%	84	Very old, tainted, rancid flavor.

The decrease in the quality of the butter caused by holding the cream too long before churning is very well shown in the foregoing table. It will be noticed that the flavor increased up to about .4 per cent of acid, when it began to deteriorate and to take on old and stale cream quality. The reason for the low score on the sweet cream was probably due to the fact that it had not been given a

chance to develop desirable flavors to counteract the odors imparted to it by the cows or the barn. So these taints were not masked in the butter. These taints were lost or overcome in the lots where it was allowed to sour slightly.

This experiment suggests that cream should not be allowed to develop more than .4 to .5 per cent of acid before it is churned. Cream held at 70-75 degrees for ten hours will develop under normal conditions about that amount of acid. It will be slightly thick and noticeably sour.

### Methods of Cream Ripening.

One of the chief causes of poor flavor or quality in farm butter is the method used in holding or ripening the cream previous to churning. With conditions so different on each farm it is hard to set a definite rule by which cream can be cared for; the same one will not apply to all conditions. Most farm cream is held or handled in farm cellars, springs, or milk-houses, and usually at a temperature of about 50-60 degrees. It is common farm practice to hold it at this temperature until enough is secured for a churning, when it is warmed and held until sufficiently sour, and then churned. Butter made from cream handled in this way is often criticised as having an old or stale cream flavor.

Some authorities have asserted that at about 50 degrees we have the best growing temperature for the undesirable fermentations in the cream, and that the characteristically old or stale cream flavor is due to these types of bacteria.

The following experiment upon methods of handling cream before churning was made to determine what practicable method best avoided these undesirable qualities:

1. Holding cream below 45 degrees until enough was secured for churning, adding each day's gathering and stirring, and when enough was secured raising the temperature to 75 degrees, and ripening over night or until .5 per cent of acid was developed.
2. Ripening the first gathering by holding it at 75 degrees until .35 per cent of acid was developed, and then cooling to cellar

temperature (55 degrees), and adding each gathering after cooling directly to the first; and so on until enough had been secured for a churning; then churning the whole without further ripening.

3. Adding a quart of good butter-milk to the first gathering, adding each subsequent day's gathering to that, and holding all at cellar temperature until enough was secured for a churning; if not sour enough then, ripening by warming to 75 degrees until .5 of acid was developed, and then churning.

4. Holding the gatherings at 55 degrees until enough was secured for a churning.

The cream used in all churnings came from the same source. The churnings were conducted as nearly as possible in the same manner. Four repetitions were made at intervals of about a week apart. The average results were as follows:

#### Methods of Holding Cream.

Methods	Percentage of acid	Scorings of butter from churnings				Score after one month for churning No. 1 and 2	
		1	2	3	4	No. 1	No. 2
	Average						
Held at 45 degrees ....	.52	92½	91	91½	91	90	90
Ripened at 75 degrees, then held at 55 .....	.55	93½	92	93	92	89	90
Held at 55, butter-milk added .....	.57	93½	91½	94	91	86	87
Held at 55 until churning secured .....	.42	92	90	90	91	84	86

These results indicate that methods Nos. 1, 2 and 3 are superior to No. 4 in securing good quality in butter. They also indicate that for keeping quality the butters from methods Nos. 1 and 2 were much superior to those from Nos. 3 and 4. This is probably due to the better control of the desirable types of bacteria in these former two methods.

#### THE EFFECTS OF METHOD AND AMOUNT OF WORKING ON QUALITY OF BUTTER.

The object of this experiment was to determine the effect of the manner and amount of working upon the body, appearance, uniformity of color, and salt distribution of butter.

This study was suggested by the large amount of farm butter which is weak in body, mottled in appearance, and contains salt in a gritty condition.

For this experiment butter was taken from three churnings made by each of the three churns used.

The conditions were the same in all cases. Samples were taken at the 12th, 16th, 20th and 24th working of the butter and were examined as to quality:

#### Effect of Working Upon Quality of Butters.

##### Barrel Churn.

After 12 workings,	Badly mottled	Gritty
After 16 workings,	Badly mottled	Not gritty
After 20 workings,	Mottled	Not gritty
After 24 workings,	Not mottled	Not gritty

##### Swing Churn.

After 12 workings,	Badly mottled	Not gritty
After 16 workings,	Slightly mottled	Not gritty
After 20 workings,	Slightly mottled	Not gritty
After 24 workings,	Not mottled	Not gritty, slightly greasy

##### Combined Churn.

After 12 workings,	Mottled	Gritty
After 16 workings,	Slightly mottled	Not gritty
After 20 workings,	Not mottled	Not gritty
After 24 workings,	Not mottled	Good body, not gritty.

This study shows that the mottles in butter largely disappear after about 16-20 workings on the board and that the body of the butter is much better than with a lesser number of workings, being closer in texture and carrying less loose water. The grittiness of salt disappears at about 16-20 revolutions of the worker, this fact showing that about that amount of working is necessary properly to incorporate and to secure uniformity in the distribution of the salt.

It must be remembered that this discussion of the amount of working applies to the particular conditions of temperature, etc., mentioned. If the butter had been colder, the room cooler, and the salt cold or of poor grade, further working would have been necessary to overcome mottles. Differences in the quality of the butter-fat, such as differences which may be caused by feed, seasons of the year, etc., will affect the working requirements of the butter.



### Churning Factors Which May Cause Poor Quality or Lack of Uniformity in Butter.

The purpose of this experiment was to determine how far the common defects in uniformity and quality of farm butter, made from good farm cream, could be overcome by control of the churning conditions.

In the studies of farm butter it was deemed best to take some cream in ordinary farm conditions and to try to secure a first class butter from it by controlling the factors in churning that were thought to be causing a lack of uniformity and quality in farm butter.

Farm cream was taken as it was brought into the college creamery. This cream was selected from the general supply of sour cream delivered by patrons; therefore, it fairly represented an average of sour farm cream. It showed upon test 0.5 per cent of acid. The churning process followed strictly the general directions given in another part of these studies for the production of uniform farm butter.

The butter was scored by a Federal Butter Inspector, as were all other samples in these studies. The results given in the table below are the averages from three churnings with each churn, made in such manner that the cream from a single day's supply was used with each of the churns. These churnings were made during June, 1913.

Qualities of Butter From Farm Cream.

Churn	Moisture	Salt	Score
Barrel .....	14.2	2.7	90
Swing .....	13.8	1.05	90
Combined .....	14.8	1.87	90½

These results show that butter with a moderately high moisture content may be secured from average cream. The moisture content seems to be most influenced by the manner of churning and working, rather than by the kind of churn used. The quality also is somewhat influenced by the method of making as well as by the condition of the cream used.

### Moisture and Uniformity of Quality Control in Farm Butter.

The object of this experiment was to produce, if possible, from cream handled and churned under farm conditions, butter of good quality and of moisture content approaching that usual in creamery butters, and to show the degree of uniformity in butter quality that can be secured with different styles of churns.

Creamery butter has been under inspection by the United States Department of Internal Revenue with regard to its moisture content, but not until lately has farm butter come under the same inspection. It is now necessary for the farm butter producer to consider the factors that influence the moisture content in his product. It is claimed by some that butter with high moisture content is superior in flavor and handling quality to butter containing a very low moisture content. This matter is of importance also because the quantity of butter made depends to a certain extent upon its moisture content. The incorporation of an excessive amount of moisture in butter is not advocated, especially if its purpose is to secure a larger quantity of butter, and quality should never be sacrificed to quantity; nevertheless a higher moisture content than is now usual can be carried in the average farm butter without sacrificing quality in the least.

This experiment shows, in fact, that with the larger amount of moisture secured the quality of the butter improved; but butter which contains 16% or more of moisture is classed as adulterated butter and subjects the maker or dealer to a fine.

These churnings were made during the summer, June 1 to August 15.

A quantity of cream was taken directly from the separator. This cream was allowed to ripen at a temperature of sixty-five degrees until it had developed .6% acid; it was then cooled to the churning temperature that was to be used (fifty-two degrees), and held at that temperature for three hours, when it was divided into three lots and churned in the barrel churn, the combined worker churn, and the swing churn, respectively. The cream was churned until the granules were the size of a small grain of corn; the butter-milk was then drawn off and an amount of wash water equal

to the original volume of cream was placed on the butter in the churn. The butter was given fifteen revolutions in the wash water and the latter was then taken off. This process left the butter in the loose, granular form and in a quite firm condition. In the case of the swing and barrel churns, the butter was then placed on a hand-worker, spread out loosely, and three-fourths of an ounce of fine butter salt for each pound of butter-fat was spread evenly over it. The butter was then worked by using the sharp side of the worker, and by cutting rather than mashing it. As soon as the butter was thus spread out over the board, it was piled up from the ends with a paddle and again worked with the lever. This method was continued until the lever had been used sixteen times. By this time the butter was free of all excess water; it had assumed a rather dry appearance, and the grain showed a steel break, that is, the butter was compact and uniformly fine in grain. It was printed in regular pound prints, held in the refrigerator for six days, and then scored by a Federal Butter Inspector. The cream used was of a good grade, and it was handled in such manner as to assist the development of the proper kinds of fermentation which helped to prevent it from acquiring objectionable odors and taints.

The scores given, with the percentages of moisture obtained, as well as the details of the making, are presented below:

### Observations.

	Barrel Churn	Swing Churn	Combined Churn
Condition of cream.....	.6 acid	.6 acid	.6 acid
Time required to ripen.....	8 hrs.	8 hrs.	8 hrs.
Time held.....	3 hrs.	3 hrs.	3 hrs.
Per cent fat.....	28 %	28 %	28 %
Approximate fullness of churn.....	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
Temperature at which churned.....	52°	52°	52°
Time to churn.....	45 min.	40 min.	30 min.
Size of granules.....	Pea	Pea	Pea
Temperature of butter-milk.....	58	59	58
Amount of wash water.....	30 lbs.	30 lbs.	35 lbs.
Temperature of wash water.....	54 degrees	54 degrees	54 degrees
Revolutions in wash water.....	15	15	18
Revolutions on worker.....	16	16	18
Score of butter.....	91	91	91
Per cent moisture.....	14.8	12.4	14.7
Per cent salt.....	2.7	1.9	2.6

The moisture content was much higher than that commonly found in farm butter, the average being 13.9 per cent for the three churnings, while the average of over sixty samples of butter made on farms throughout the State and tested at this Station averaged only 11.9 per cent, after short keeping under conditions not favorable to evaporation.

In the case of the small combined churn, the butter was handled in the same manner as with the other churns, except that it was salted and worked in the churn. One and one-quarter ounces of salt per pound butter-fat was used, as the butter was worked with the gate to the churn closed and the water that was worked out of the butter in the churn was thus held. This excess water readily takes up some of the salt, hence more salt must be used to get the proper amount into the butter. It was possible to work the butter longer in the churn, because it was protected from the warm air of the room and did not become warm so quickly. It was worked with eighteen revolutions instead of sixteen, as in the case of the other churns.

Since butter begins to reincorporate moisture after about the fourteenth working, an advantage is gained by giving it further working in the water of the churn, and in this way securing a greater overrun.

The butter-maker should use a churning temperature sufficiently low to produce a butter firm enough to stand the longer working in the churn.

#### Stages of Moisture Changes in Farm Butter.

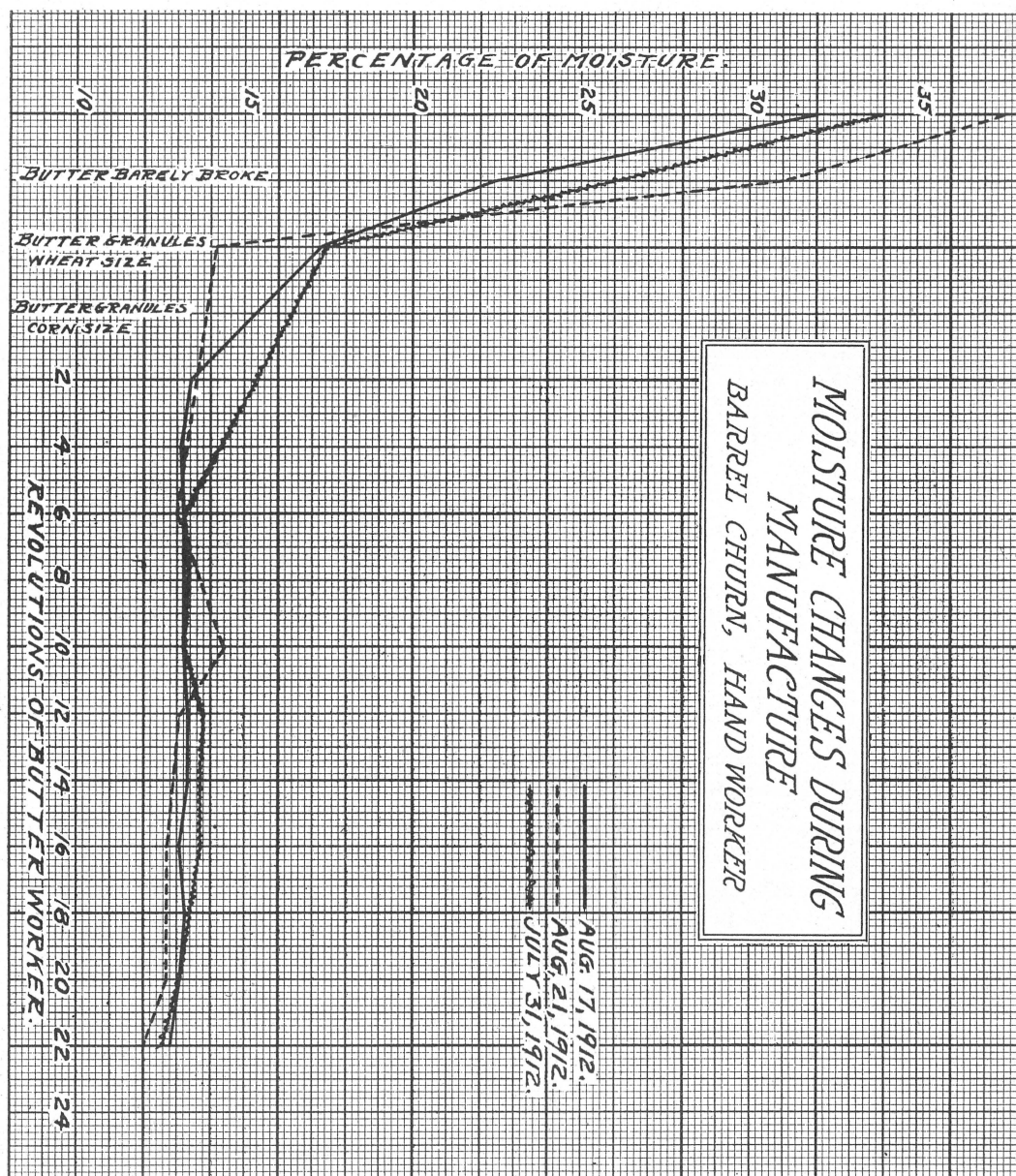
This experiment was made to determine the moisture changes in farm butter as the working progressed. Samples were taken from the churn before salting and also at every two revolutions of the worker until the butter was considered finished. The moisture percentages for each of the three churns are given in the table which follows. They are based on the average of three churnings from each churn:

## Observations.

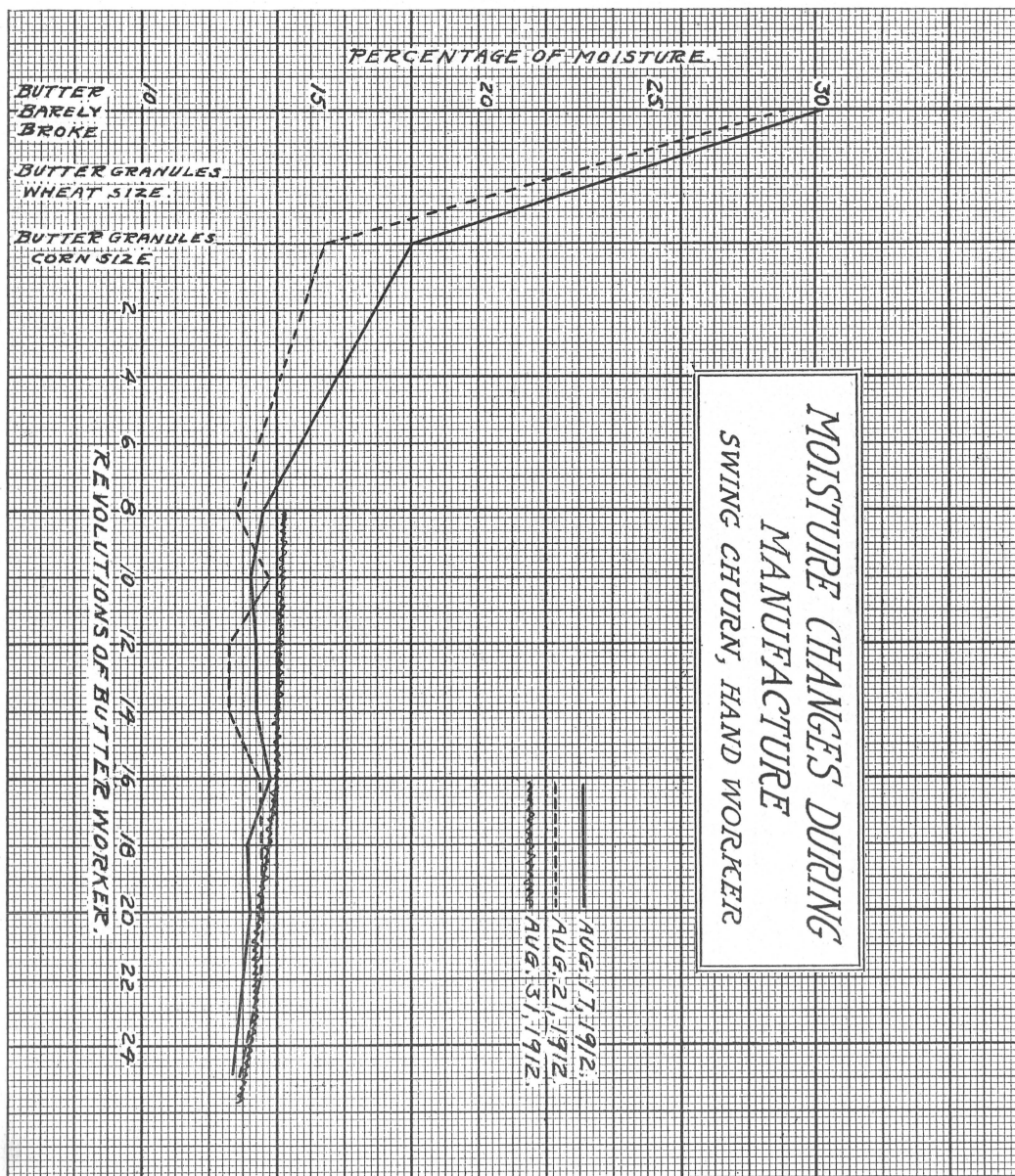
Condition of Butter	BARREL CHURN				SWING CHURN				COMBINED CHURN AND WORKER			
	Per cent moisture				Per cent moisture				Per cent moisture			
				Av.				Av.				Av.
Broke .....	37.6	34.4	32.8	34.93	29.2	....	30.0	29.60	21.0	....	26.0	23.50
Wheat-size..	30.8	26.8	22.6	26.73	....	....	....	....	22.6	20.2	18.4	20.40
Corn-size...	14.2	17.6	17.4	16.40	15.4	....	17.8	16.60	17.4	16.4	14.4	16.06
2 Workings..	....	....	....	....	....	....	....	....	....	13.6	13.2	13.40
4 Workings..	....	....	13.4	13.40	....	....	....	....	....	13.2	13.2	13.20
6 Workings..	....	....	13.2	13.20	....	....	....	....	....	13.0	13.4	13.20
8 Workings..	13.0	13.2	13.2	13.13	12.8	14.2	13.6	13.53	13.0	12.8	12.8	12.80
10 Workings	13.8	13.4	13.2	13.46	13.8	....	13.2	13.50	....	12.6	13.2	12.90
12 Workings	14.6	13.2	13.2	13.66	12.6	....	13.4	13.00	12.8	....	13.2	13.00
14 Workings	13.2	14.0	13.4	13.53	12.6	....	13.4	13.00	12.8	13.4	13.8	13.00
16 Workings	13.0	13.8	13.4	13.40	13.6	14.0	13.8	14.80	12.6	....	13.8	12.70
18 Workings	12.8	13.8	13.2	13.26	13.6	....	13.2	13.40	12.6	....	13.0	12.80
20 Workings	12.8	13.6	13.4	13.26	13.6	13.6	13.2	13.26	12.6	13.8	13.4	13.20
22 Workings	12.8	13.0	13.2	13.00	13.4	13.4	13.0	13.26	12.8	13.8	14.2	13.60
24 Workings	12.2	12.8	....	12.50	....	....	12.8	12.80	....	....	14.2	14.20
26 Workings	....	....	....	....	....	12.8	....	12.80	....	....	....	....
40 Workings	....	....	....	....	....	....	....	....	....	14.8	....	14.80

By these churnings it is shown that just as the butter starts to "break" it contains a high per cent of moisture, but that this varies greatly in percentage in the same and in different churns. This is due probably to the difficulty in securing the exact size of granules each time. This seems contrary to the opinion that butter contains more moisture in the corn-kernel stage than in the wheat-grain stage. More moisture is here shown in the wheat-grain stage. It seems that in the case of all three churns the moisture content of the butter drops quite uniformly until the beginning of the working. In the case of the swing and barrel churns, the butter was worked on a table-worker which caused the moisture to drop slightly as the working progressed. This is caused by the water running off as the butter is worked. This water is lost to the butter or there is less moisture in the finished product. This seems to be true of all hand-worked butter in cases where the water that is driven out of the butter runs off the working board.

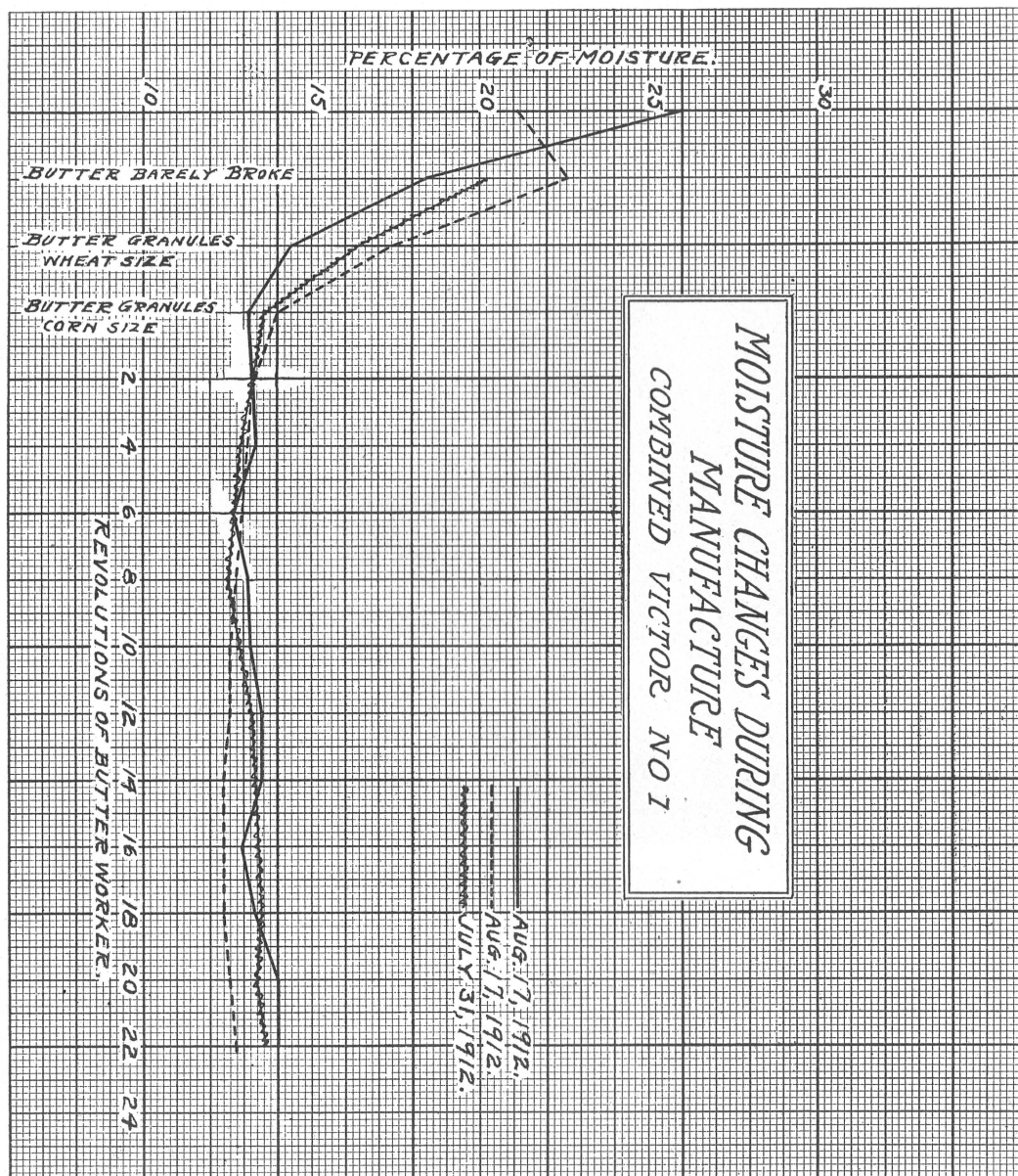
In the case of the combined churn, the change in moisture content was very much the same as with the other two types of churns, until the working of the butter was commenced. After the butter had been worked from about 16-20 revolutions it began to take up moisture. The water that was previously expelled from the butter was still held in the churn and came into contact with the butter as it was being worked, and was gradually incorporated





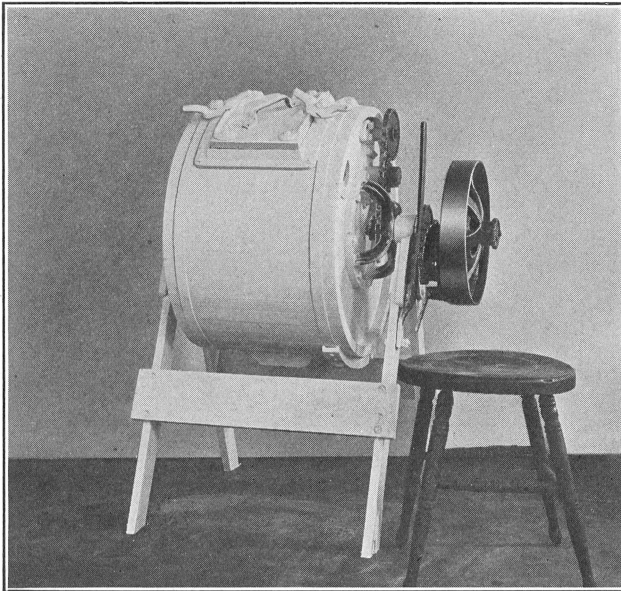






to a small extent; thus the moisture content was temporarily raised, though it was again lowered as the working progressed further.

This experiment seems to show that the combined churn has the advantage in yield over the other churns with which the table-worker was used in controlling the moisture content of the butter.



**Small Combined Churn and Worker.**

One significant fact is brought out with respect to the three churns. The moisture content rose in all cases where the butter was worked from about eight to twelve times. This is hard to account for unless at this point the salt had begun to be uniformly distributed through the butter and acted momentarily to delay the working out of the moisture. The salt at this point probably began to absorb moisture and had a tendency to draw the excess moisture into the butter.

## **DIRECTIONS AND METHODS SUGGESTED FOR MAKING UNIFORM DAIRY BUTTER OF GOOD QUALITY**

### **HANDLING CREAM.**

The production of good butter of uniform quality starts with the cow. Milk from unhealthy cows can never be made into first-class products. Neither can cows that are kept in unclean, insanitary places produce clean milk.

The maker of butter on the farm can have complete control of his milk from the time it is drawn from the cow until it is made into butter. This is not true of the creameryman or manufacturer, who has to secure his product from outside sources over which he has no supervision. This advantage which the farm butter-maker possesses means much to him if he realizes it and makes the most of it.

The cows should always be brushed off and kept clean at milking time. Care should be taken that all utensils be kept clean and in good condition, so that the cream, whether skimmed or separated, shall be good, clean, sweet and not absorb any undesirable taints or odors. Much butter which would otherwise be good is damaged in flavor because care is not taken to keep dirt and impurities out of it. Milk which is not separated by a cream separator should be at once cooled by some suitable method and held as cold as possible until the cream has risen. As soon as the cream is separated it should be cooled down.

### **PERCENTAGE OF FAT IN CREAM.**

If a separator is used the percentage of fat in the cream may be regulated. When it is impossible to test the cream for its percentage of fat, regulating the separator, so that about 12-14 per cent of the total milk is separated and comes out as cream, will give approximately the proper richness to the cream. The best results will be obtained when the cream has about 28-30 per cent of fat;

cream with too high a percentage of fat has a tendency to adhere to the sides of the churn, which causes difficult churning and increases the danger of loss of fat in the butter-milk.

When the cream is too thin or has too small a percentage of fat in it, as in the case of hand-skimmed cream containing from 12-20 per cent of fat, good, uniform churning is hard to secure. Such cream loses too much fat in the butter-milk and also requires longer churning.

### METHODS OF RIPENING.

Probably no other one factor is so largely the cause of poor quality in farm butter as the lack of proper ripening previous to churning. On the farm it is often necessary, in order to secure a sufficient amount for a churning, to store the cream from two or more days' milkings. The common method now in use on most farms is simply to collect in a cream can or jar successive creamings, until enough has been secured for a churning. The cream is meanwhile held in the cellar, milk-house, back porch, or spring house. The temperature at which it is held varies with the weather, season of year, and other conditions. The cream under these conditions usually ripens or develops acid until at the end of three or four days it becomes sour, and is then stirred and churned. If it is kept too cold for ripening during this holding period, it is warmed for several hours, and allowed to sour before churning.

This practice is a bad one, as it occasions many of the taints and off flavors found in farm butter. The reason for this is that the temperature of the cream is usually about fifty-five degrees, which is a little too low to secure a good growth of the lactic or acid-forming bacteria which produce the proper flavors in the cream. It is claimed by some that at this average cellar temperature there are present the proper conditions for the growth of the bacteria that produce objectionable flavors and taints in cream. These undesirable bacteria produce no acid, will not grow well in the acid medium, and seem to grow best at a temperature of 50°-60°.

The rest of the experimental work carried out to determine the best way to ripen cream on the farm indicates that there are three other methods, any one of which will give better results than the storing of cream at cellar temperatures. They are: (1) Holding or storing the cream at a very low temperature (below forty-five) until enough is secured for a churning, and then warming it up to 70°-80°, and ripening; (2) ripening the first collection of cream at once and adding each skimming to it, from day to day, until a churning is secured; (3) adding a portion of butter-milk to the first cream gathered and then adding each skimming until enough is secured for a churning.

The first method is a good one for butter-makers who have ice for keeping the cream cold. The method is to cool to forty-five degrees or below immediately after separating each day's cream gathering, and to hold the total amount at this low temperature until enough is secured for a churning. The cream for the churning is then warmed up to seventy-five degrees until the proper amount of acid is developed in it. By holding the cream at seventy-five degrees under these conditions for about twelve hours, the proper percentage of acid will usually be developed.

The second method advocated is ripening at about seventy-five degrees until .3 per cent of acid is developed in the first separation that is to form the new churning, then cooling this down to the temperature of the spring house or cellar, and adding each creaming, after it has been cooled, to this lot until enough is secured for a churning. This will, under average conditions, give about enough acid development in the whole churning for best results. The ripening of the first separation of cream develops a large number of lactic acid bacteria and produces some acid, which serves to hold in check the undesirable types of bacteria.

The third method is to add a portion of butter-milk of good quality to the first separation; and to add the succeeding creamings and hold the whole amount at cellar or spring house temperature until a sufficient quantity is secured for a churning. If the ripening has not sufficiently developed by that time, the temperature can be raised to seventy-five degrees, and the cream allowed to ripen to the proper amount of acid.

The object in the last two methods is essentially the same—to hold in check undesirable bacteria by having developed or introduced into the cream a preponderance of the desirable bacteria and a small amount of acid. The latter two methods are simple, handy, and require no special apparatus. Care must be taken, however, in the last method to make sure that the butter-milk comes from butter of a good flavor and quality. The using of butter-milk of medium or poor quality is very likely to produce butter of much the same kind as that from which the butter-milk was secured.

### **AMOUNT OF ACID TO DEVELOP, OR DEGREE OF RIPENING.**

Large amounts of farm cream are ripened or soured too much before churning. Because of this it develops an old and tainted or stale flavor. Cream ripened until it is sharply sour contains usually from .6 to .8 per cent of acid, which is too much. The best flavors and keeping quality seem to be secured when it is ripened about .4 to .5 per cent of acid. Where no acid test is used, this amount of acid may be approximated. The cream should taste only very mildly sour. Cream naturally ripened at 70°-75° will develop about this amount of acid, if held ten hours.

### **THE USE OF STARTERS.**

Starters are not much used on the farm and when used are generally of the natural kind, that is, made up of butter-milk or good sour milk. They are very desirable, if care is taken to use only good butter-milk or sour milk, and will in most cases improve the quality of the butter produced. They are especially desirable when cream is hard to churn because of improper ripening, and where it is difficult to secure proper ripening. The amount to use varies with the condition of the cream, but from 10-20 per cent is a suitable quantity in most cases.

The natural starter made from sour milk is perhaps the best for farm conditions. To make it, set several samples of good, clean skim or whole milk in small jars until the milk becomes sour. The

holding temperature should be about seventy degrees. When the samples have become sour, they should be examined. They should have a good, smooth curd formed free from gas bubbles. The flavor and taste should be clean and sharply sour. The sample showing the best flavor and condition of the curd should be selected for the starter. It may be built up in larger quantities by adding the sample to about ten times its volume of clean, sweet skim-milk and allowing the mixture to stand at about seventy degrees until it has coagulated. This coagulated milk is then the starter to use in the cream-ripening process. It contains a preponderance of the desirable lactic bacteria which are necessary for that process.

The amount of starter to add to cream varies from 8 per cent to 50 per cent. If the starter is a good one, the more added the better, but if too much be added it will dilute the cream too greatly and make it hard to churn. About ten per cent is a common amount to use.

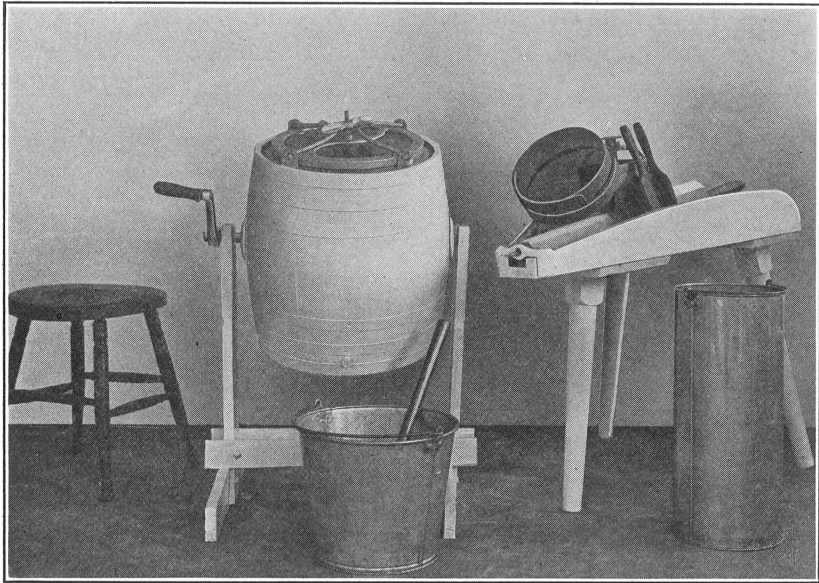
### CHURNING TEMPERATURE.

The temperature at which cream is churned is very important. When the cream has been ripened properly, it should be cooled down to the temperature at which it is to be churned and held at that temperature at least two hours to allow the fat to become cool and firm enough to churn.

The churning temperature varies widely. It is affected by the season of the year, kind of feed given the cows, condition of the cream, and temperature of the churning room.

In the spring and summer, when the cows are fresh and the feeds succulent and soft, the butter-fat is naturally softer than later in the season, so that a lower temperature should be used, about 52°-56° being proper under average conditions for these seasons. This temperature should be increased to about 56°-60° in the winter. Much cream is now churned on the farms at above 60 degrees. Experiments seem to indicate that the lower temperatures are to be preferred, as butter is much firmer when coming from the churn, does not so easily incorporate butter-milk, and will





**Barrel Churn and Hand-Worker.**

stand more working, thus producing a better body and a more uniform quality. Because of the cream being poorly ripened or abnormal in some way, it is often necessary to use higher temperatures than are here given. When difficulty in churning is experienced, the cream should never be raised in temperature by adding hot water to the churn, but should be poured from the churn into a can and gradually raised a few degrees in temperature by setting the can in a pan of warm water.

### **CHURNING AND KIND OF CHURN.**

The proper care of cream in the ripening process, although very essential, does not insure good butter. Good cream can easily be spoiled in churning. Unless the churn is kept in good condition it is impossible to make good butter with it. The churn should always be well scalded out and well cooled down before using. There are two reasons for this; first, the hot water will scald out

and kill all molds that may be growing in the wood and will close the pores of the wood so that the cream or butter will not adhere to it; second, so that the temperature of the cream will not be raised while churning and yield soft, greasy butter.

While many churns have been invented, there are few that meet with general approval and use. The best churn for average farm use is one that is very simple, easy to keep clean, and durable. The common barrel churn meets all these requirements and is a general favorite on the farm. There are several other types used in large numbers, such as the swing churn, dash churn, and combined churn and worker. In selecting a churn, great care should be taken to secure one which will not excessively agitate the cream, thus causing poor body by incorporating butter-milk in large quantities in the butter.

In general a churn of ample capacity, made of hard wood, free from peculiar odors or taints, sanitary in construction, and easy to cleanse should be selected.

#### LENGTH OF TIME TO CHURN.

The length of time best for churning varies with the condition of the cream, but ranges from fifteen to thirty minutes. If the cream churns in less than fifteen minutes, the butter is very likely to be too soft to work well and will have a poor body when finished. Cream that requires much longer than thirty minutes may be improperly ripened or abnormal in some way. Taking the cream from the churn and raising the temperature in the manner suggested above will in most cases overcome the trouble.

The churning should stop when the butter begins to collect in the butter-milk in granules from the size of a pea to that of a grain of corn. Granules of this size do not contain so much butter-milk as do larger ones. The butter is easier to wash, salt, and work.

#### WASHING OF BUTTER.

It is a common practice on the farm to wash butter through several wash waters. This is unnecessary, if the churning has been stopped at the right time. If the granules are about the size of

pea to corn grains, one washing will remove all the butter-milk. Too much washing has a tendency to give the butter a flat taste, by removing the finer flavors. Use about the same amount of wash water as of cream churned.

The temperature of the wash water varies considerably, but it should not be much higher or much lower than the churning temperature. Very cold wash water is to be avoided, as cold water absorbs the flavors of the butter readily, causes brittleness of body, and poor quality in the butter.

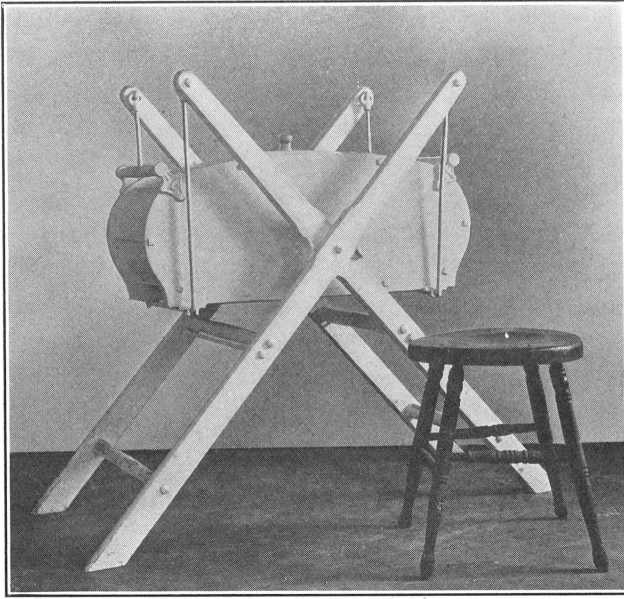
Where a low churning temperature is used, the washing temperature may be the same as that for churning, and it should never be more than four to six degrees less. Where a higher temperature is used for churning the washing temperature may differ as much as from 4 to 10 degrees from that of the churning. The wash water should be pure and clean, and free from odors or taints, as they will be readily absorbed by the butter.

### WORKING AND SALTING THE BUTTER.

After the wash water is drawn from the butter—unless a combined churn and worker is used—the latter should be taken out in the loose, granular form and placed on the working-board or table. This table should be clean and thoroughly wet with cold water. Butter will stick to dry, warm, or dirty boards.

To the butter on the working-board fine dairy salt of the best quality should be added. The quantity varies with the taste of the maker and the markets on which the butter is sold, but, under average conditions where the butter is worked on a hand-worker, three-fourths of an ounce of salt to each pound of butter-fat is a desirable amount to use. A larger amount, from the above to one and one-quarter ounces of salt per pound of butter-fat, must be used in the combined churn. This larger amount is necessary because of the wash water which is held in the churn.

After the salt has been evenly distributed over the granules of butter, the working should commence. It is a common practice to let the butter stand with the salt on it for a while before working.



**Small Swing or Cradle Churn.**

This is unnecessary if the butter is in a good granular condition, firm in body, and the salt fine and of a good grade.

The working should be given by first using the sharp edge of the worker to cut and flatten the butter out into a thin sheet. This sheet should then be folded to the center of the working board, and the process repeated.

The working of butter accomplishes three important things: It evenly incorporates the salt, excludes the excess water, and makes the body compact. The working should be continued until the excess water no longer appears, and the salt is worked evenly through the mass. The texture of the body may be ascertained by breaking off a piece of the butter. The break should show a brittle, grainy appearance, similar to that of broken steel.

#### **PRINTING AND WRAPPING.**

When the butter has been sufficiently worked it should be printed into some desirable shape. The common rectangular one-

pound mold is the best to use, as it makes a neat, attractive print and is easy to handle.

After the butter is printed it should be wrapped in a good grade of parchment butter paper. This is very essential. Much butter is wrapped in cloth or oiled paper. This is a very bad practice, as the cloth holds molds, which readily grow and produce taints and odors. The oiled paper, if kept for any length of time in a warm place, becomes very rancid and imparts undesirable flavors.

It is always advisable to have the name of the producer or his farm name on the wrapper of the butter, if it is sold on the market. If the butter is of good quality this will tend to increase the sales and be an incentive to the highest effort for maintaining uniformity in quality. The attractiveness and neatness of the package always helps to sell the butter, often at much above the average market price.

### THE CARE OF FARM CHURNS AND APPARATUS.

After the butter is taken from the churn, the latter should be rinsed out with warm water, and the rinsing followed by a thorough washing with very hot water. The rinsing out with warm water will remove any butter-milk which may remain in the pores of the wood. The hot water will remove any fat which may be left in the churn.

It is never well to use soap powders on the interior of the churn, but the occasional use of a small amount of dairy washing powder or lime water is beneficial.

To keep the churn sweet and free from odors and taints a small handful of lime placed in some water in the churn or in the last rinsing of the churn is very effective. It is very essential in good butter-making to see that all apparatus used is absolutely clean and free from undesirable odors and taints, as these are quickly absorbed by the butter.

Temperature, care, and cleanliness are three vital factors in good butter-making.



